12th European Solar Physics Meeting
8 - 12 September 2008
Freiburg, Germany

Electronic proceedings

For further information on the meeting,
for all abstracts of talks and posters
as well as other articles of these proceedings,
please visit the following web site:

http://espm.kis.uni-freiburg.de

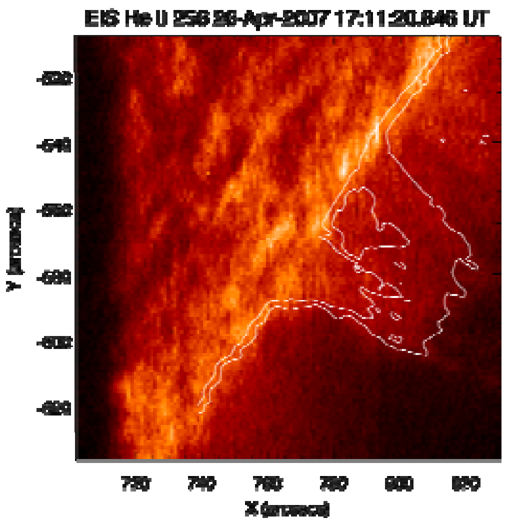
edited by Hardi Peter
Kiepenheuer-Institut für Sonnenphysik
Freiburg, Germany
peter@kis.uni-freiburg.de

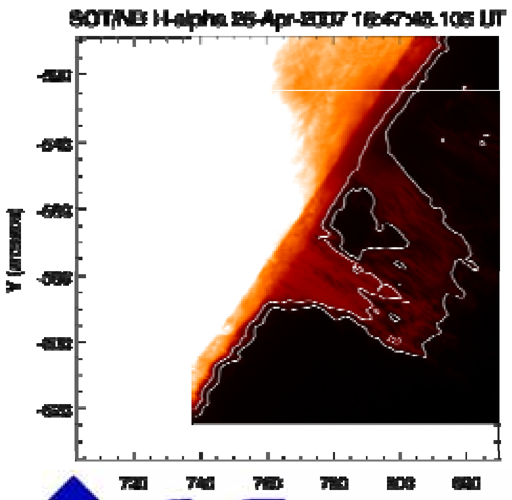
Tuesday 12:00-12:15

Solar Prominence Diagnostic with Hinode/EIS

Labrosse, N.[1]; Schmieder, B.[2]; Heinzel, P.[3]; Gunar, S.[3]
[1]University of Glasgow; [2]Observatoire de Paris Meudon; [3]Astronomical Institute of Academy of Science of the Czech Republic

We report here on observations of a solar prominence obtained on 26 April 2007 using the Extreme Ultraviolet Imaging Spectrometer (EIS) on Hinode. Selected profiles for lines with formation temperatures between log(T)=4.7 and log(T)=6.3 are given and are used to explain the existence of dark features in the raster images. We estimate the contribution of the He II 256.32 A line in the raster image at 256 A in the prominence region. We compare the observed prominence profiles with theoretical profiles from non-LTE radiative transfer models and deduce the contribution of resonant scattering in the He II 256 A emission.





Solar Prominence Diagnostic with Hinode/EIS

With a touch of non-LTE radiative transfer calculations

Nicolas Labrosse

University of Glasgow

Brigitte Schmieder

Observatoire de Paris Meudon

Petr Heinzel, Stanislav Gunar

Ondrejov Observatory, Astr. Inst. of Academy of Science

The International Team 123 on Spectroscopy and Imaging of Quiescent and Eruptive Solar Prominences from Space acknowledges the support of the International Space Science Institute

Observation details

Prominence observed on 25 and 26 April 2007

JOP 178: http://gaia.bagn.obs-mip.fr/jop178/

– EIS:

- Rasters with 1” and 2’’ slits
- Line profiles in [167-211] and [246-291] Å

– SOT Hα

Heinzel et al. (2008, ApJ in press)

– Dark prominence structure seen in TRACE and EIS 195 Å images

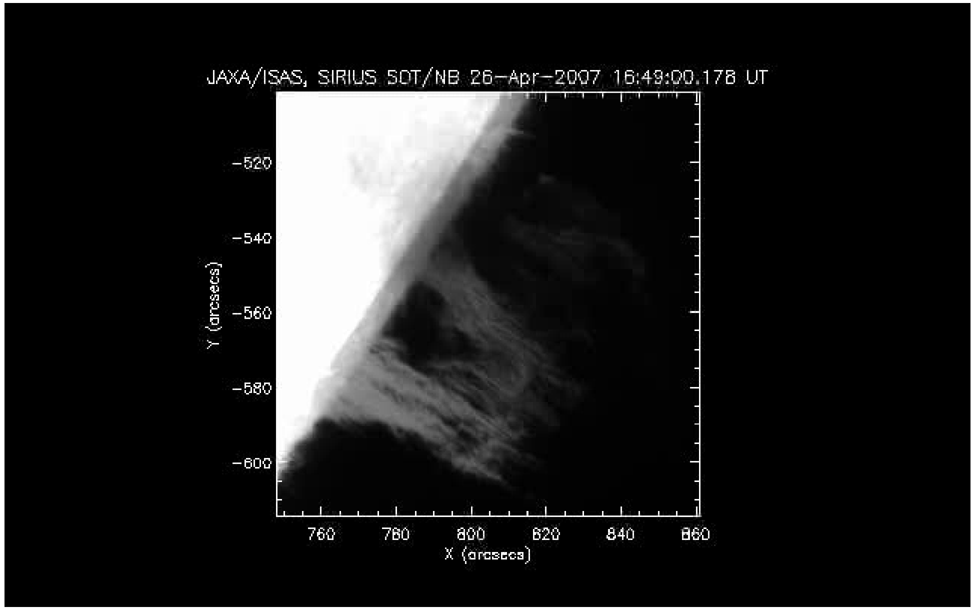
- due to absorption in HI, HeI and HeII resonance continua
- *and* to coronal emissivity blocking due to prominence cavity

–XRT void due to X-ray emissivity blocking

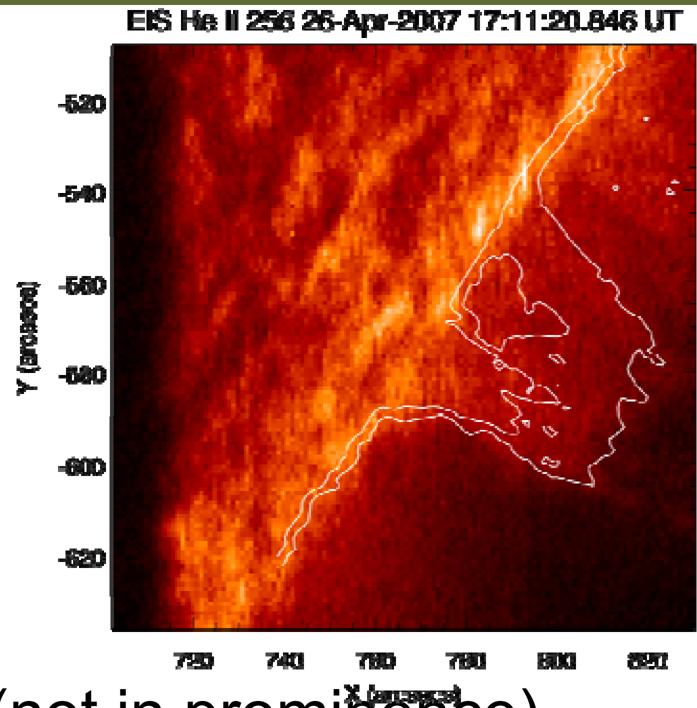
–Determination of column densities and ionization degree of H

SOT

- Movie / stills



The blend at 256 Å



A typical raster with EIS at 256 Å

Contributions from [Young et al. 2007]

- He II 256.32 Å (log T ~ 4.7)
- Si X 256.37 Å (log T ~ 6.1)
- Fe XII 256.41 Å (log T ~ 6.1)
- Fe XIII 256.42 Å (log T ~ 6.2)

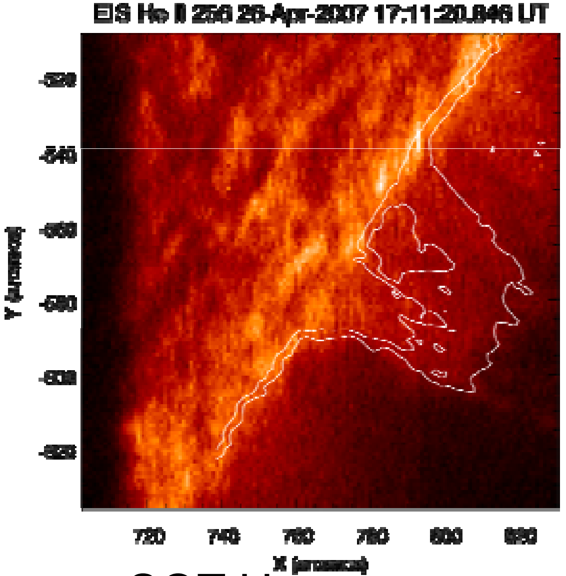
The coronal lines dominate above the limb (not in prominence)

Procedure to obtain the 'real' He II emission at 256.32 Å

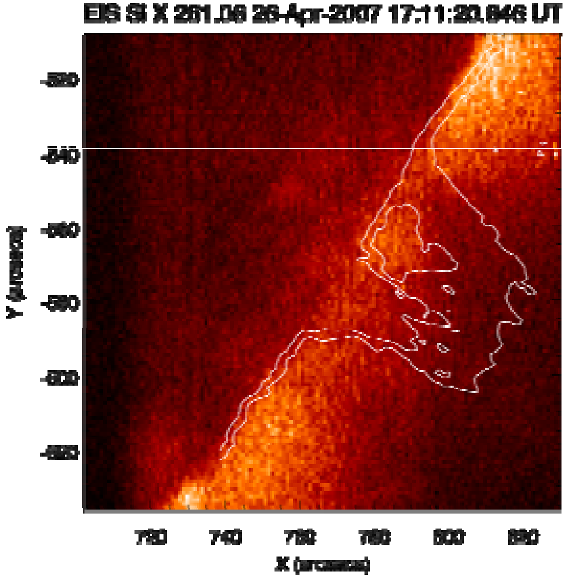
- Use Si X 261.04 Å (unblended)
  - has fixed ratio with Si X 256.37 Å
- Remove Si X 256.37 Å
- Fit resulting signal with 1 or 2 gaussians to remove Fe XII/Fe XIII

The blend at 256 Å

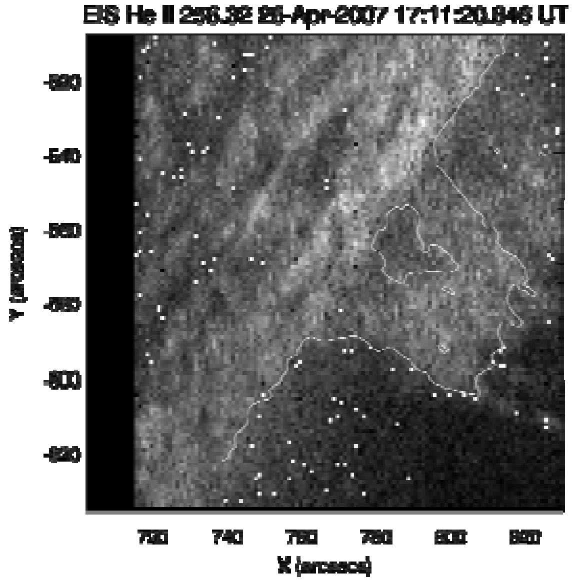
EIS raster 256 Å



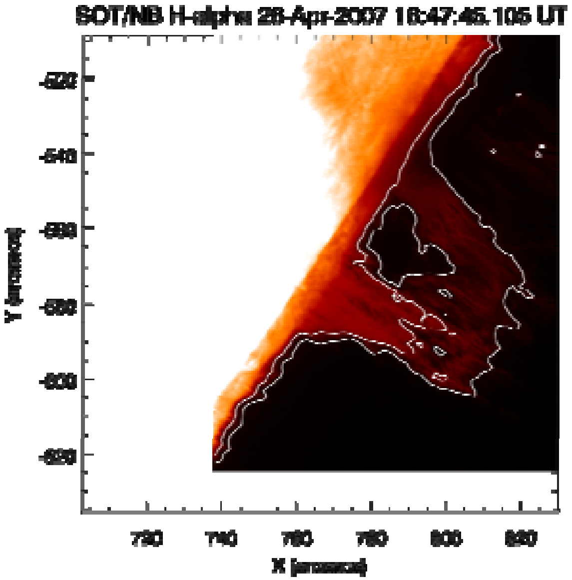
EIS raster Si X 261.04



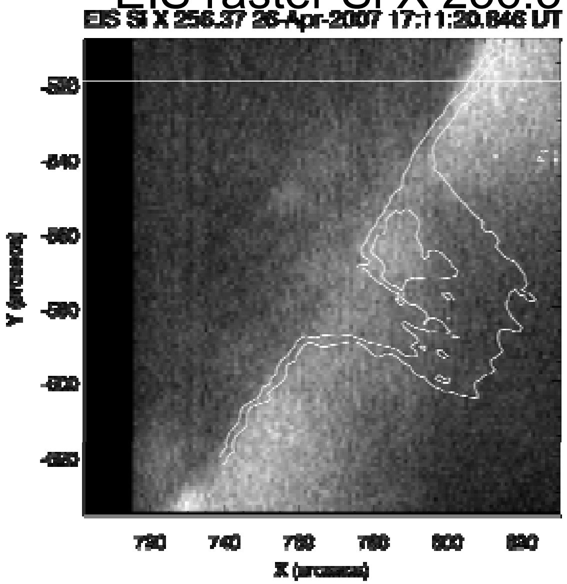
EIS raster He II 256.32



SOT Hα

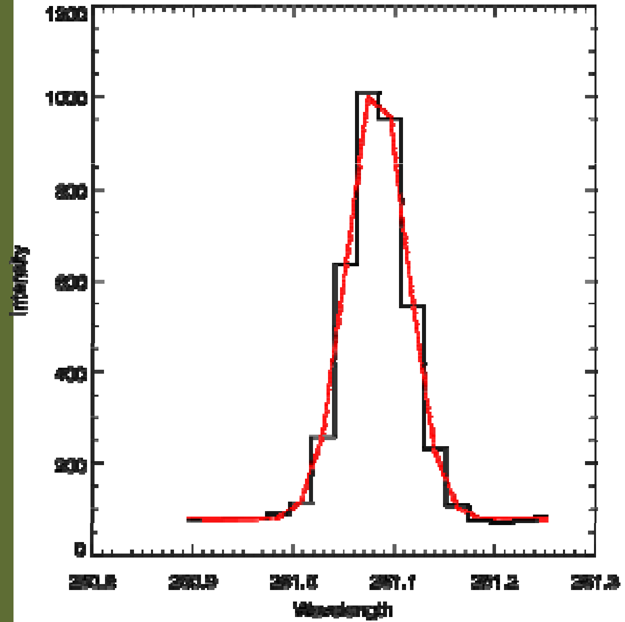


EIS raster Si X 256.37

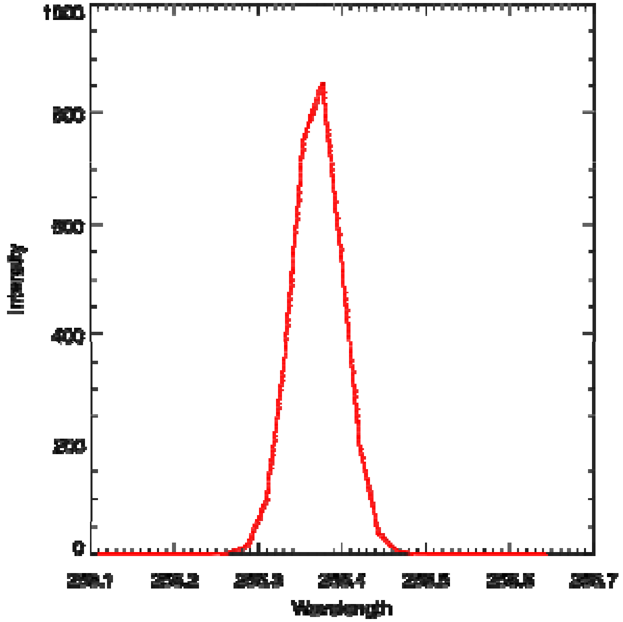


Line profiles at 256 Å in bright prominence

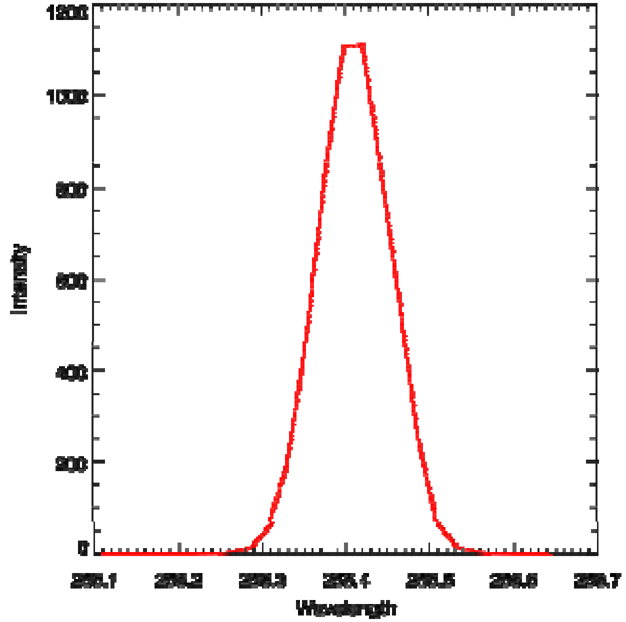
Si X 261.04



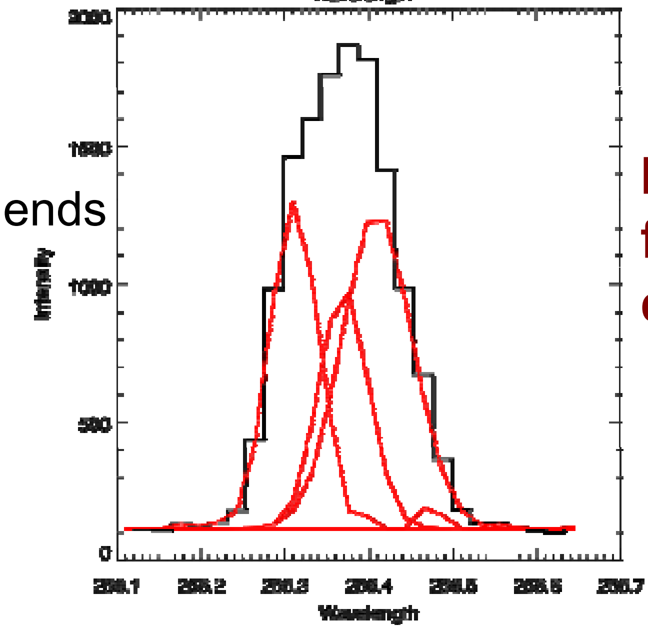
Si X 256.37



Fe XII/Fe XIII 256.4



EIS spectrum with line blends



He II 256.32 contributes for ~ 25% of the total emission!

Calculation of He II line at 256.32 Å

•1D plane-parallel vertical slab

Free parameters

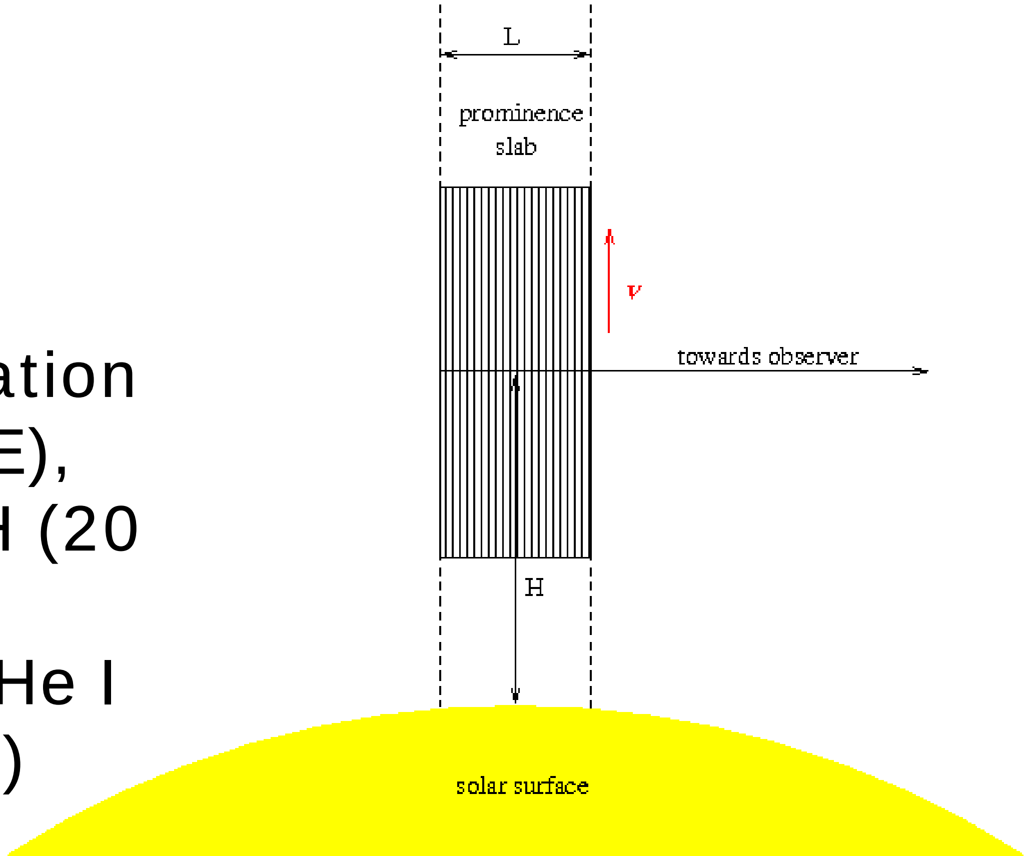
- Gas pressure
- Temperature
- Column mass
- Height above the limb
- Radial velocity

$$
\begin{aligned}
p(m) &= 4p_c \frac{m}{M}\left(1-\frac{m}{M}\right)+p_0 \\
T(m) &= T_{\rm cen} + (T_{\rm tr} - T_{\rm cen})\left[1-4\frac{m}{M}\left(1-\frac{m}{M}\right)\right]^{\gamma}
\end{aligned}
$$

Anzer & Heinzel (1999)

Equations to solve

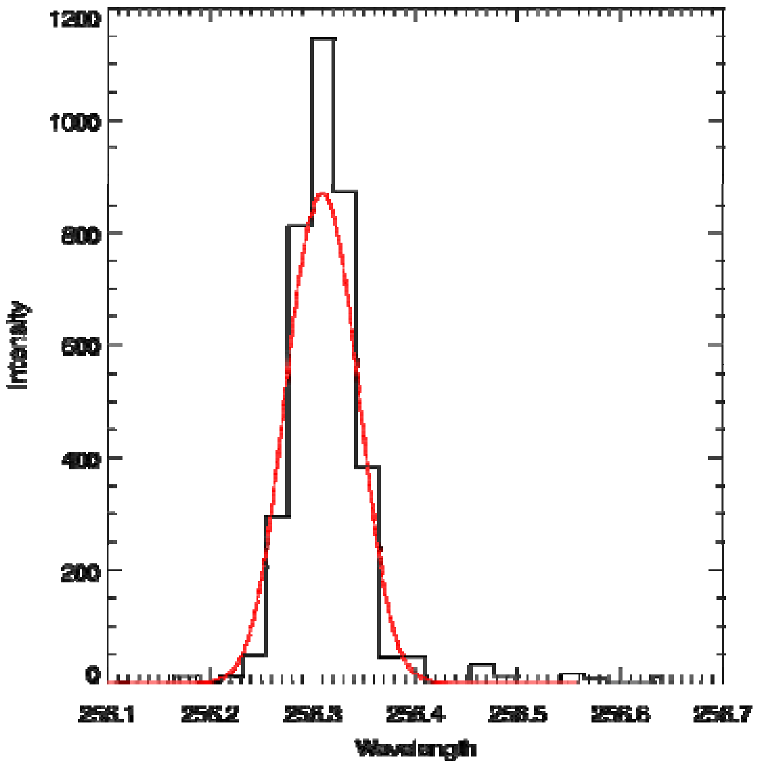
- Pressure equilibrium, ionisation and statistical equilibria (SE), radiative transfer (RT) for H (20 levels)
- SE, RT for other elements: He I (29 levels) + He II (4 levels)



Results (1)

Prominence plasma parameters

Obtained by comparison between grid of computed profiles and observed profiles



Model results

Column mass: 9×10^{-4} g cm^{-2}

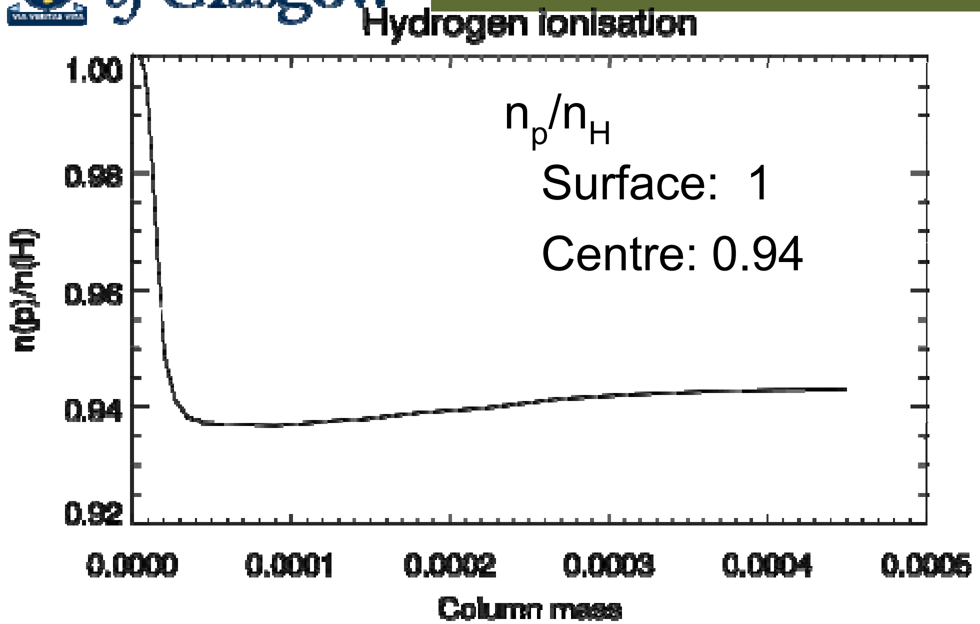
Mean H density: 8.4×10^{10} cm^{-3}

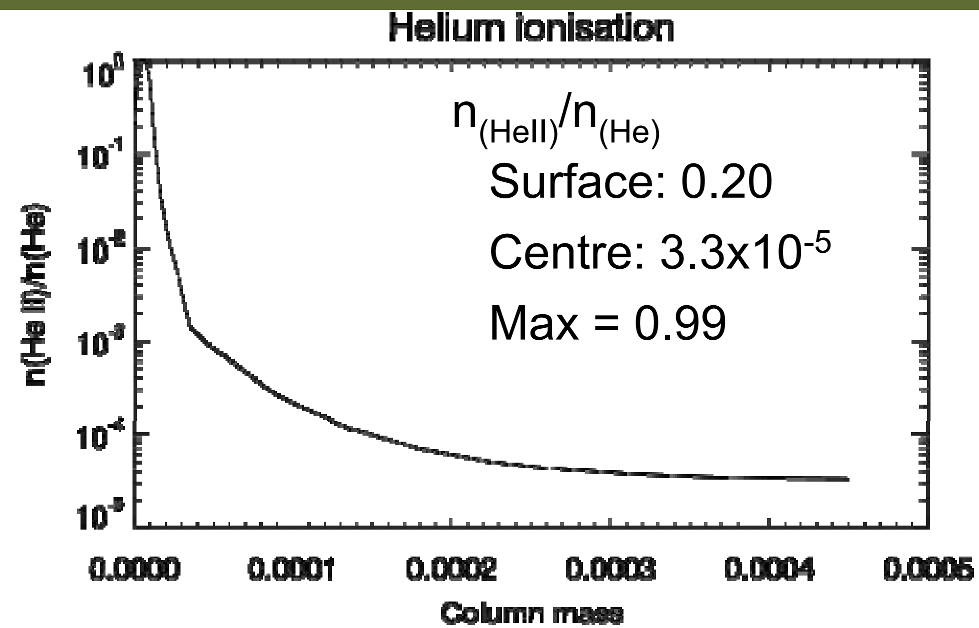
(He abundance=0.10)

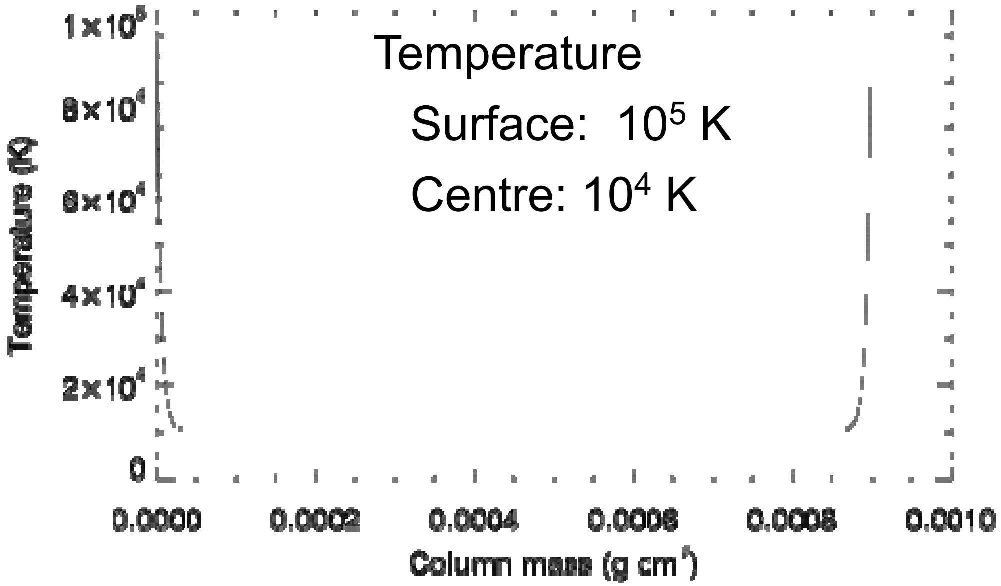
Area of bright part: 5×10^{18} cm^{2}

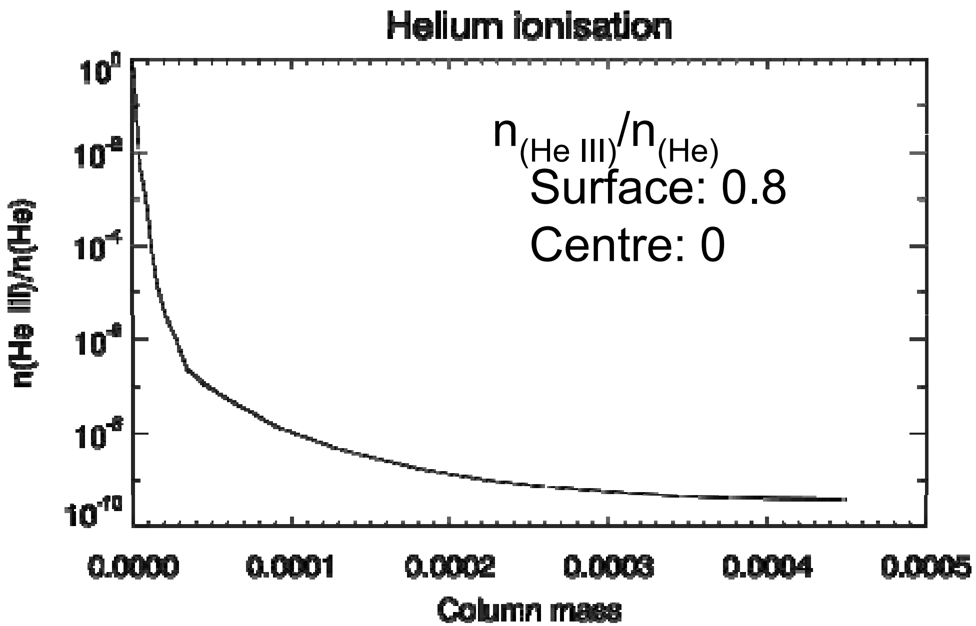
Mass: 5×10^{15} g

Results (2)


Hydrogen ionisation
n_p/n_H
Surface: 1
Centre: 0.94
n(p)/n(H)
1.00
0.98
0.96
0.94
0.92
0.0000
0.0001
0.0002
0.0003
0.0004
0.0005
Column mass


Helium ionisation
$n_{(HeII)}/n_{(He)}$
Surface: 0.20
Centre: $3.3\text{x}10^{-5}$
Max = 0.99
n(He II)/n(He)
10^{0}
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
0.0000
0.0001
0.0002
0.0003
0.0004
0.0005
Column mass


Temperature
Surface: 10^{5} K
Centre: 10^{4} K
Temperature (K)
1×10^{5}
8×10^{4}
6×10^{4}
4×10^{4}
2×10^{4}
0
0.0000
0.0002
0.0004
0.0006
0.0008
0.0010
Column mass (g cm^{-2})


Helium ionisation
$n_{(He\ III)}/n_{(He)}$
Surface: 0.8
Centre: 0
n(He III)/n(He)
10^{0}
10^{-2}
10^{-4}
10^{-6}
10^{-8}
10^{-10}
0.0000
0.0001
0.0002
0.0003
0.0004
0.0005
Column mass

Conclusions

EIS provides a new view on prominences

Enables us to probe different regions of prominences

Emission at 256 Å can be understood in this prominence as

- ~25% He II 256
- The rest coming from coronal lines (emission from the corona in front of the prominence)

The He II line is formed by

- Scattering of the incident radiation (50%-70%)
- Collisional excitation

Non-LTE computations are necessary to interpret this part of the spectrum